

Cross Layer Workshop Washington 2004

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Outline

- Introduction
- Cross Layer Design
- MAC layer Approach in Ad Hoc networks
- Network Layer Approach in Ad Hoc networks
- On going work

Introduction

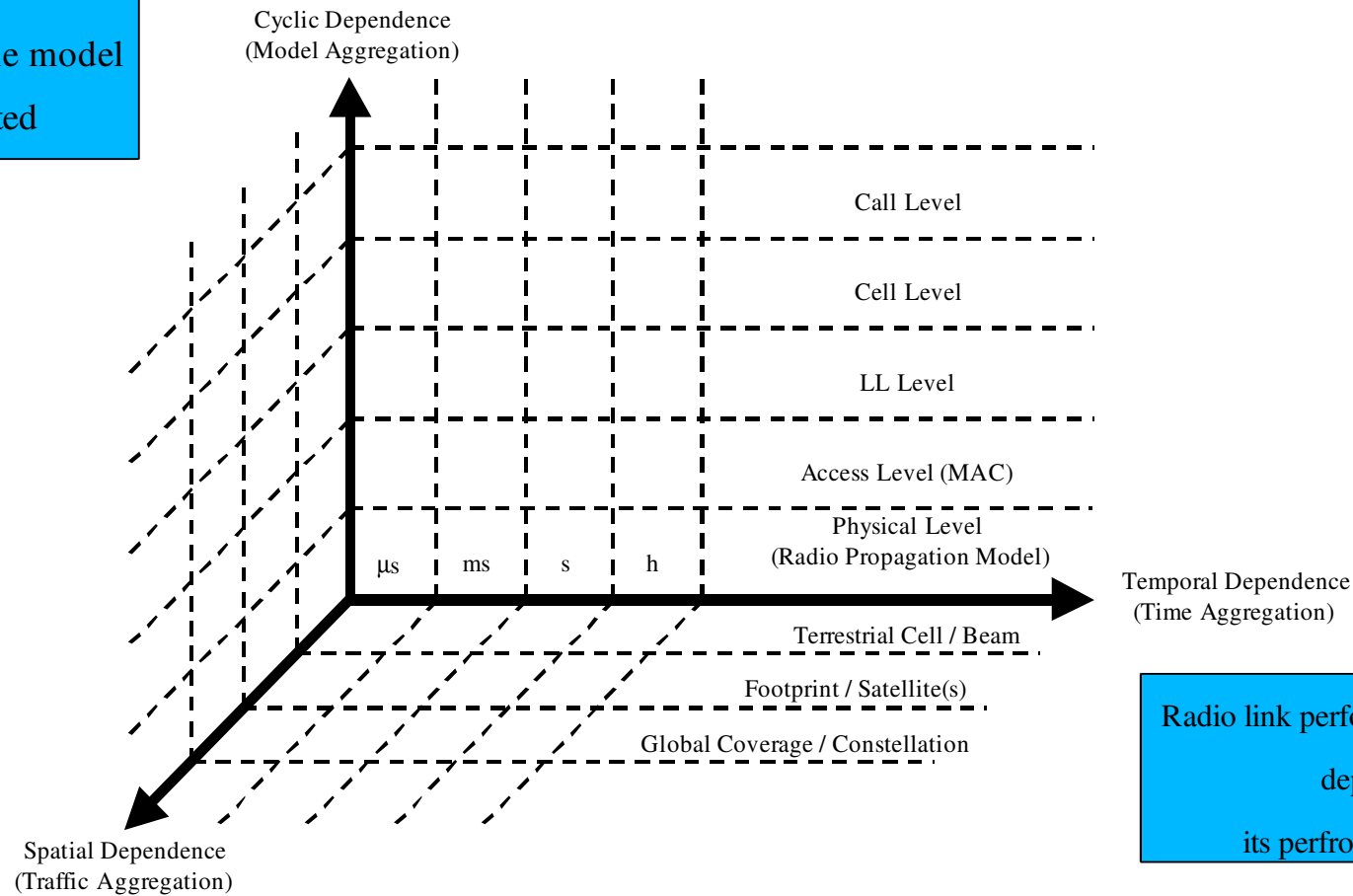
- Goal of Cross Layer:
 - Improve the performance of the whole network stack
- How to improve performance
 - The information in a layer could be use by other layers
- How to share information between layers
 - Change the stack design

Introduction

- Aggregation methods are used to solve complex problems
- A complex problem is divided into sub-problems
- This method may be exact
- It is often an approximate method
- It is often recursively applied: a fixed point method until convergence of parameters

Introduction

Several part of the model
are correlated



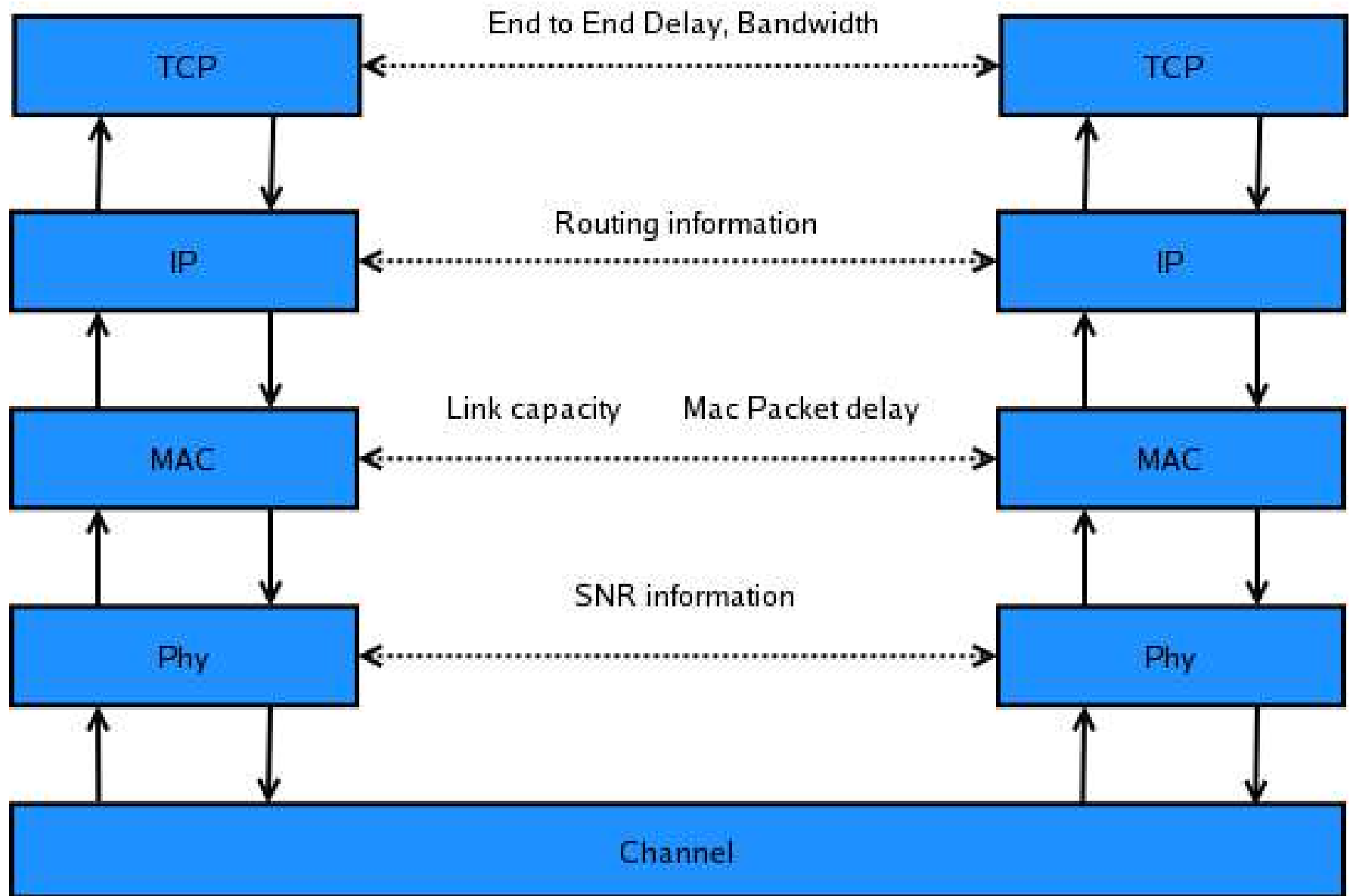
Radio link performance at time $t + I$
depends on
its performance at time t

Performance on site S at time t
is related to the performance
on a close site S' at t or near t

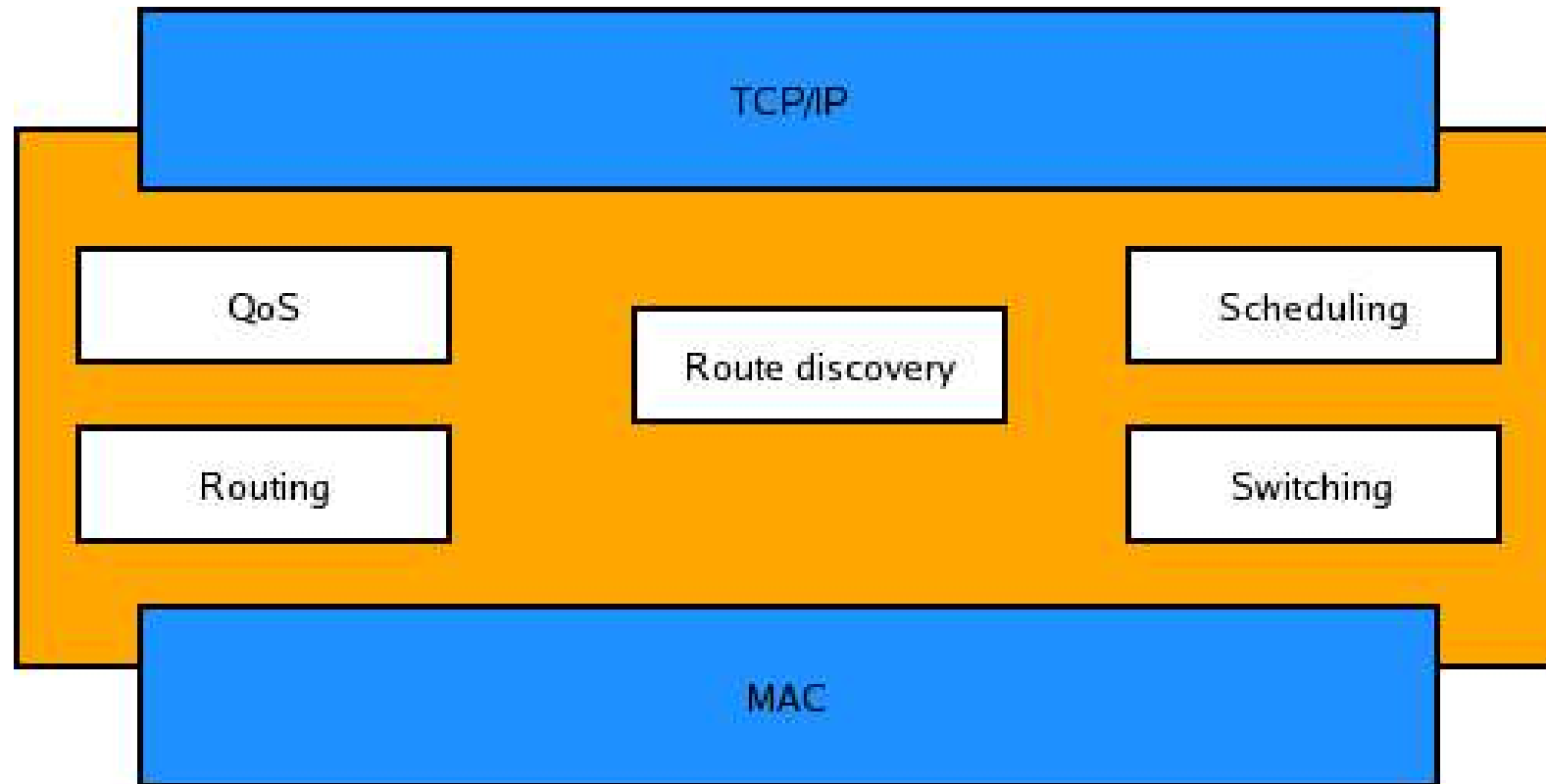
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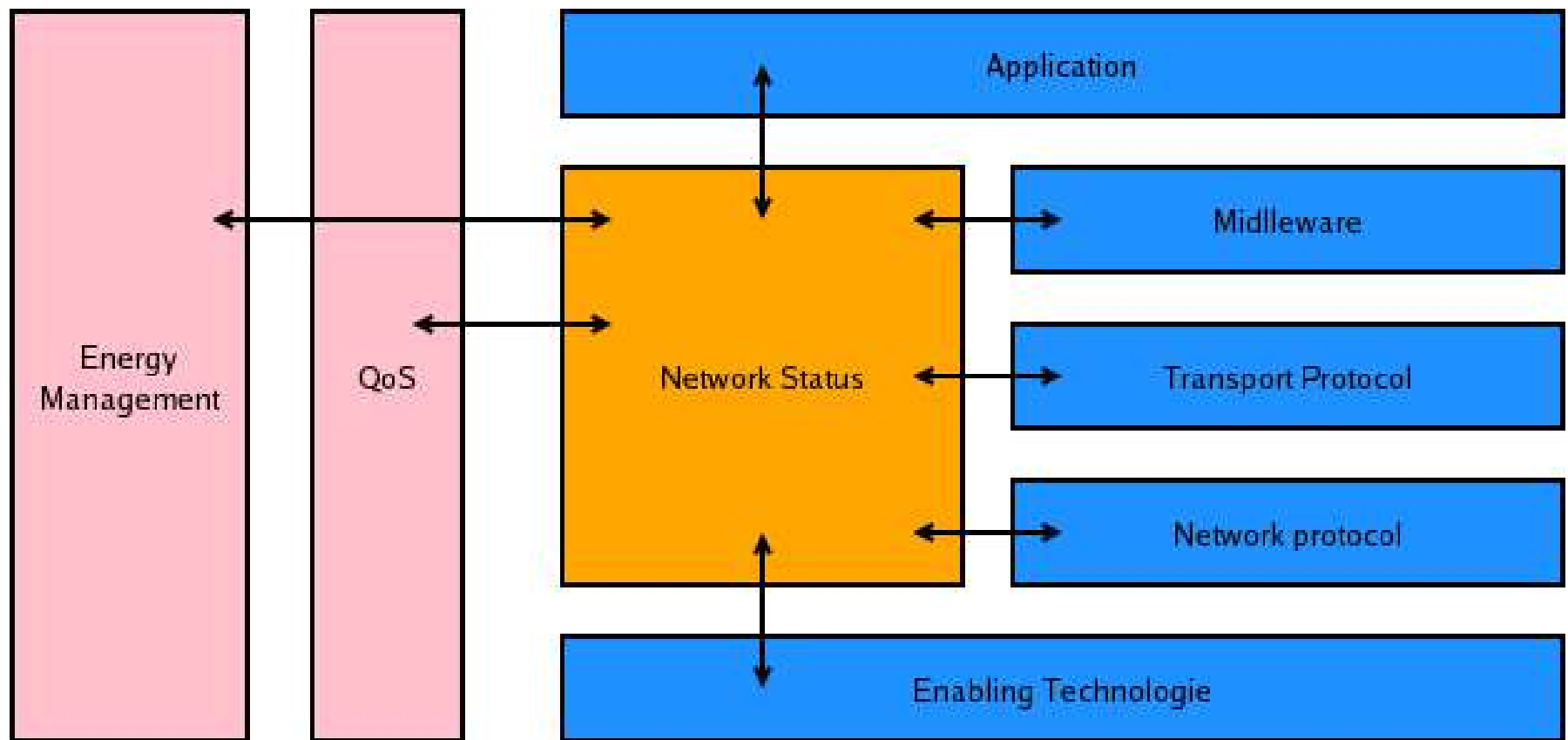
Cross Layer (1/4) : Current Stack



Cross Layer (2/4) : Current way of research



CrossLayer (3/4): New Design



Cross Layer (4/4): New Design

DME: Device Management Entity

LME: Layer Management Entity



Vijay T. Raisinghani, Sridhar Iyer. **Cross-layer design optimizations in wireless protocol stacks.** *Computer Communications (Elsevier)*, 2003

Cross Layer Goals

- Use of several optimization methods at the same time
- Share information
- Ad-hoc Network Protocol Architecture can lead to optimize performance by exploiting environmental parameters across different layers

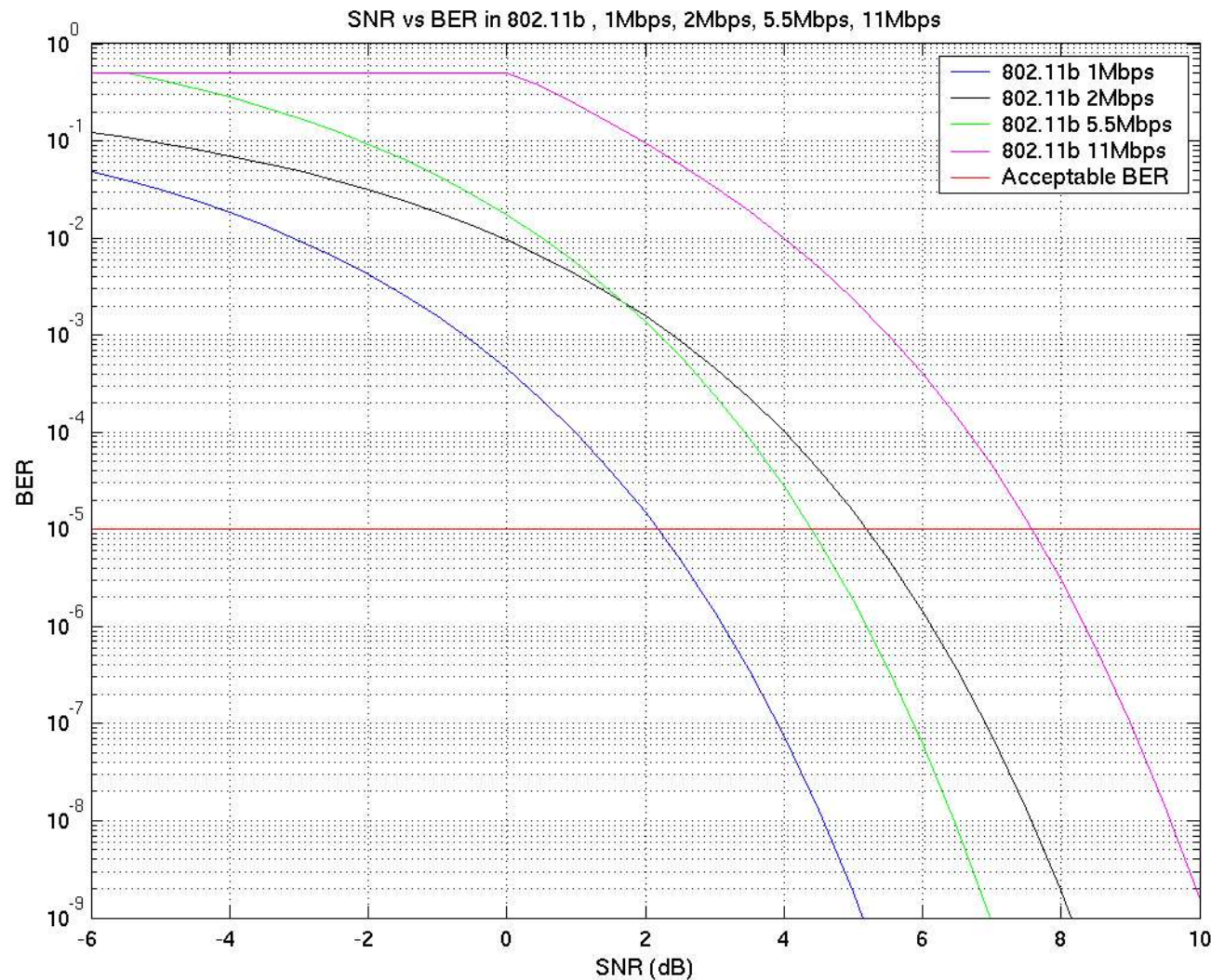
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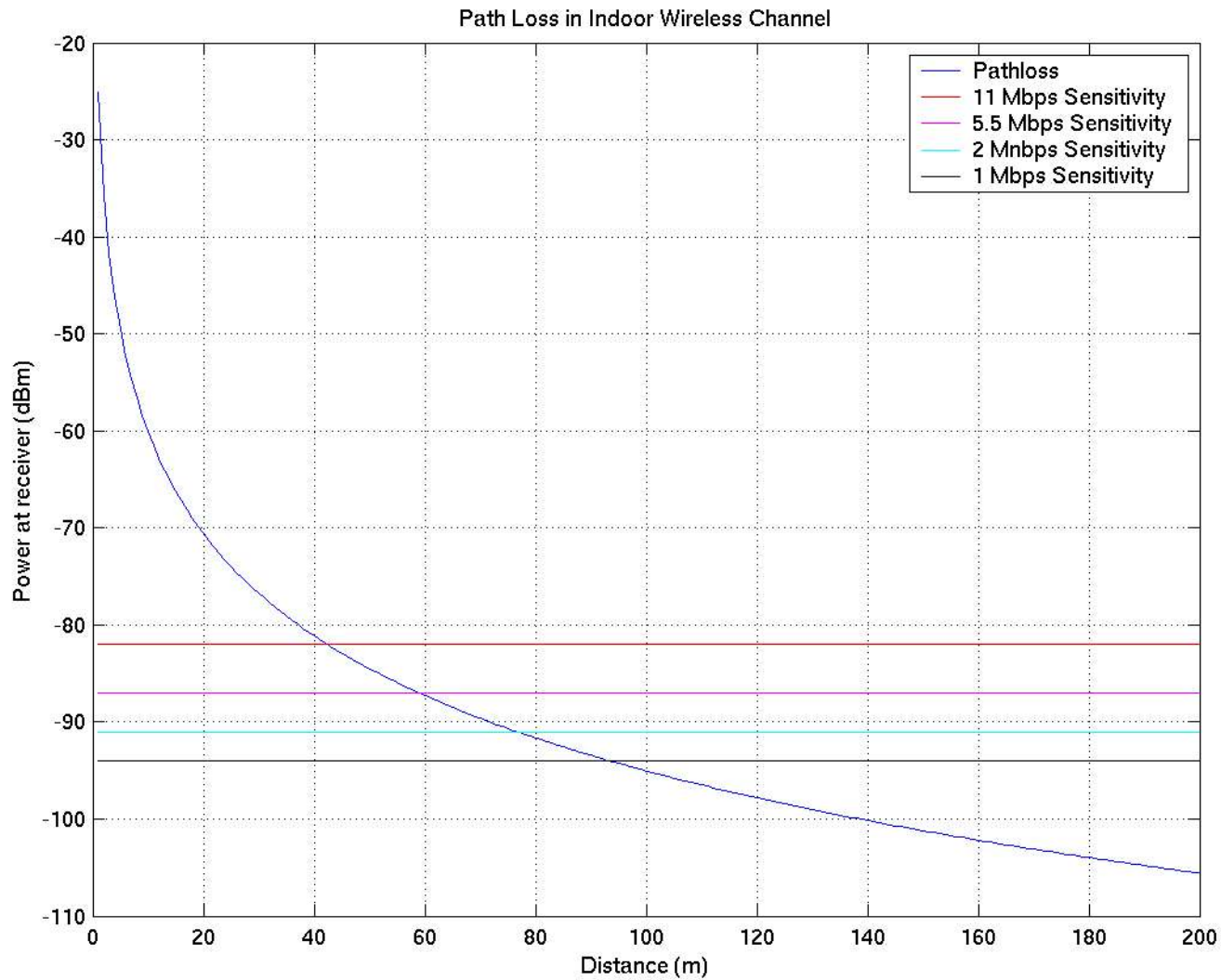
Introduction

- How the SNR affects throughput
- How the number of hops affects the throughput
- Detect the SNR level to improve the path throughput
- Effect of the multi-rate

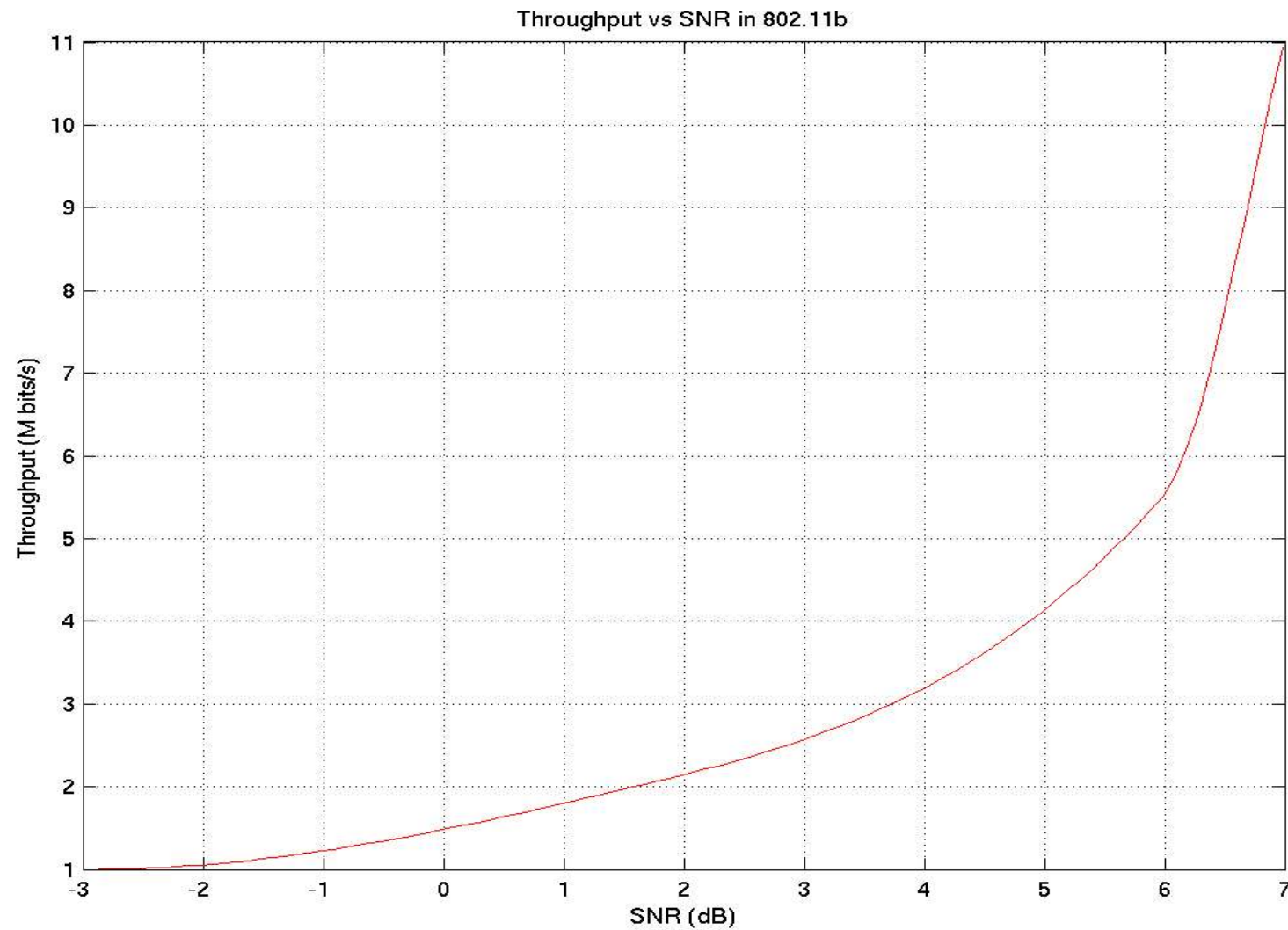
BER vs SNR simple models



Path Loss



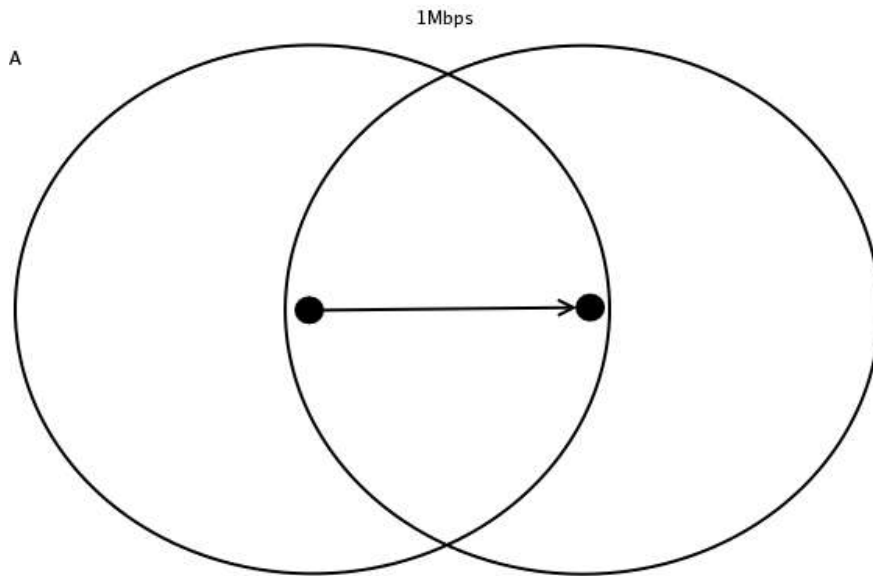
Throughputs vs SNR



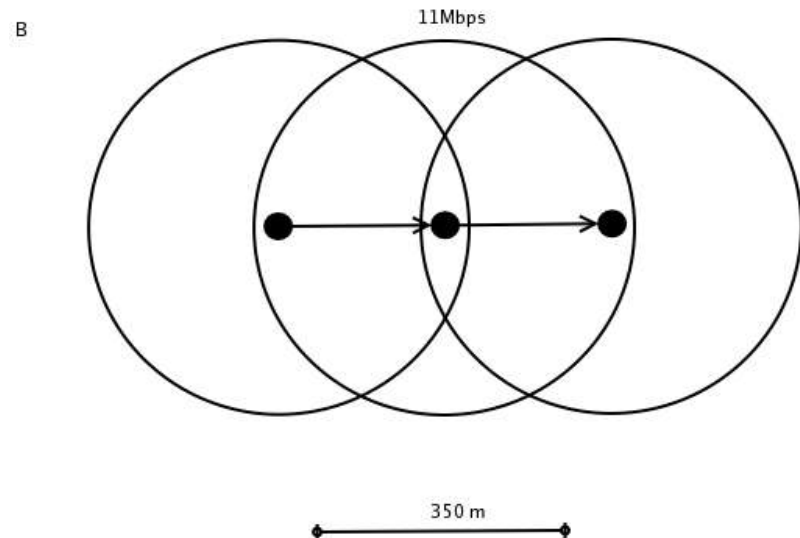
Effect of Multi-rate in 802.11b

- SNR affects the throughput
- Selecting the best available throughput is equivalent to select the best SNR along the path
- Need to change the metric
- Hops count versus throughput

Path Selection



- Long distance = low throughput



- The number of hops is not always the best metric
- Determine the best trade of between hops and throughput

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Multiuser Diversity

- Apply multiuser diversity to wireless ad-hoc networks
- By using cross-layer mechanism to get the signal strength

R. Knopp and P. A. Humblet. **Information Capacity and power Control in Single-Cell Multiuser communication.** *In Proc. Int. Conf. On communications.* Seattle, Jun 95

R. Dube and C. Rais and K. Wang and S. Tripathi. **Signal stability based adaptive routing (SSA) for ad hoc mobile networks.** *IEEE Personal Communication.*

AODV-UU

We have implemented a cross layer mechanism with AODV-UU 0.8

- follow the RFC 3561 standard
- simulation with NS2, and testbench with Linux performed easily

AODV-UU available at

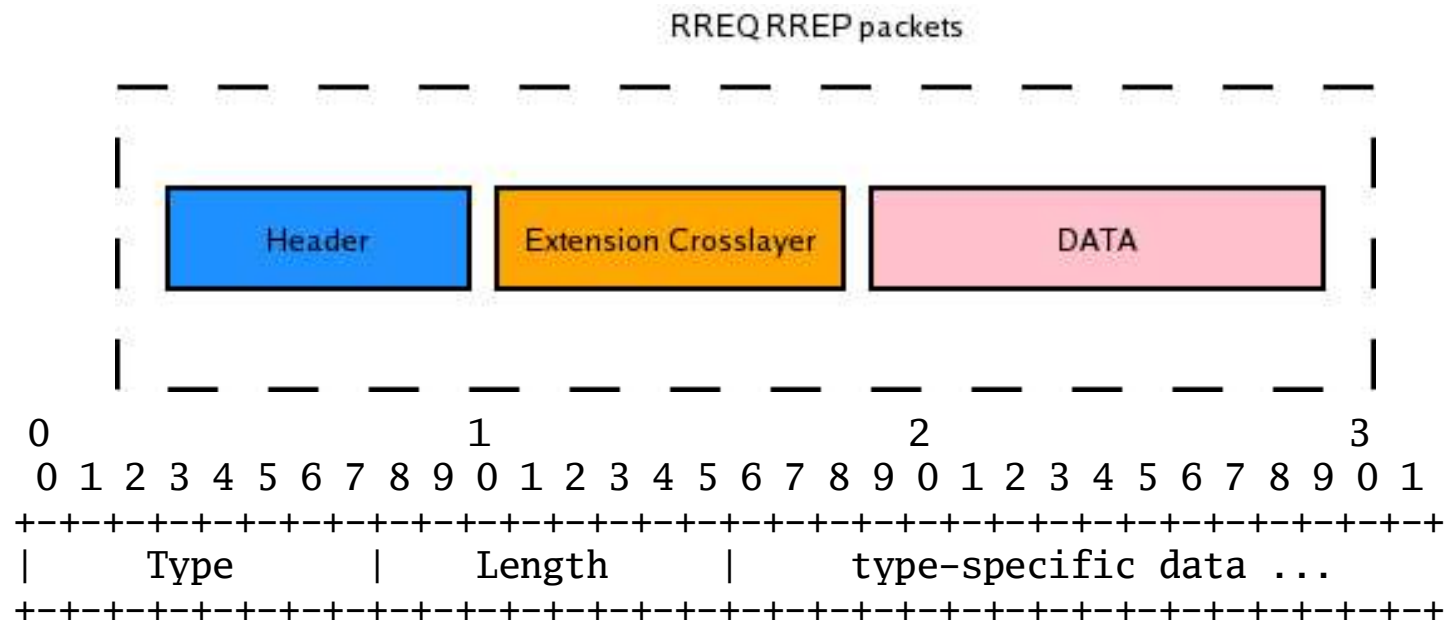
Ref aodv-uu : <http://user.it.uu.se/~henrikl/aodv/>

AODV-UU + Cross-Layer extension available for NS2 simulation and Linux TestBench at

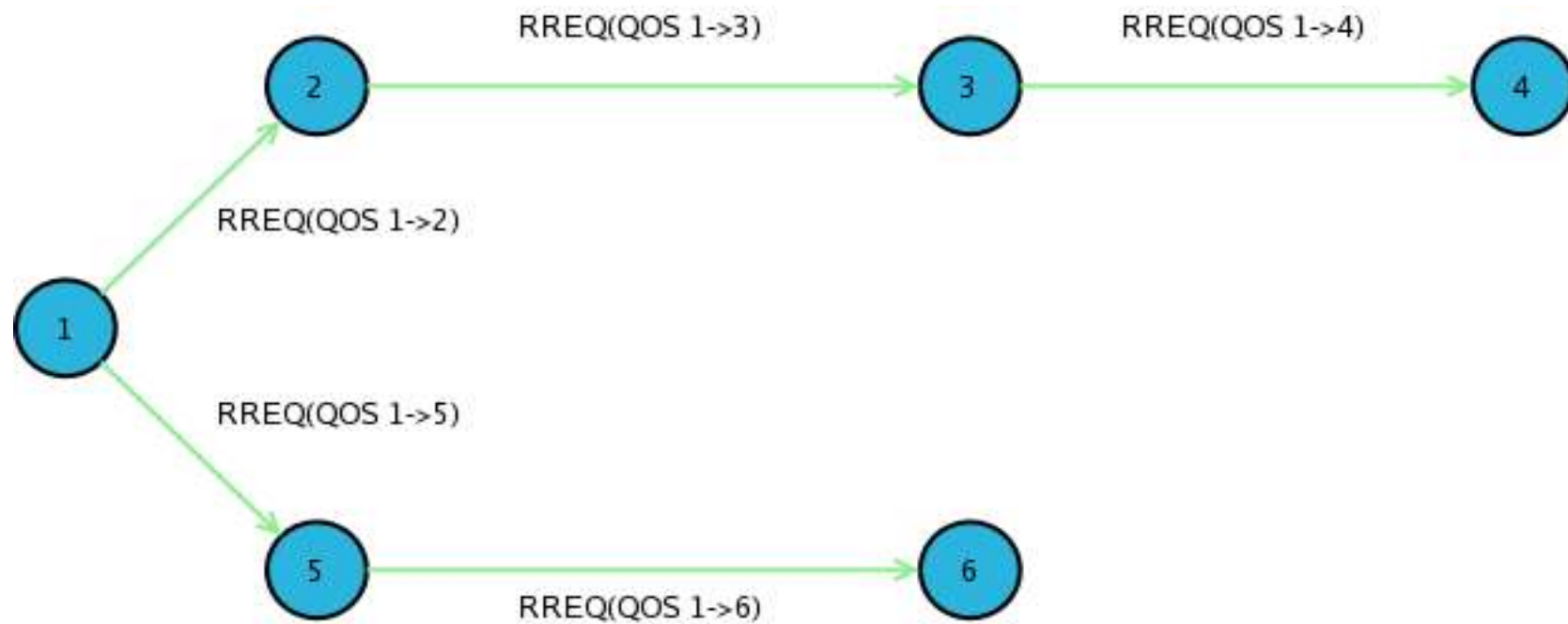
<http://www-rst.int-evry.fr/~gauthier/>

AODV-UU CrossLayer Extensions

- Add new extension to AODV
 - Type = 5 => CrossLayer extension
 - Data = add the new Metric

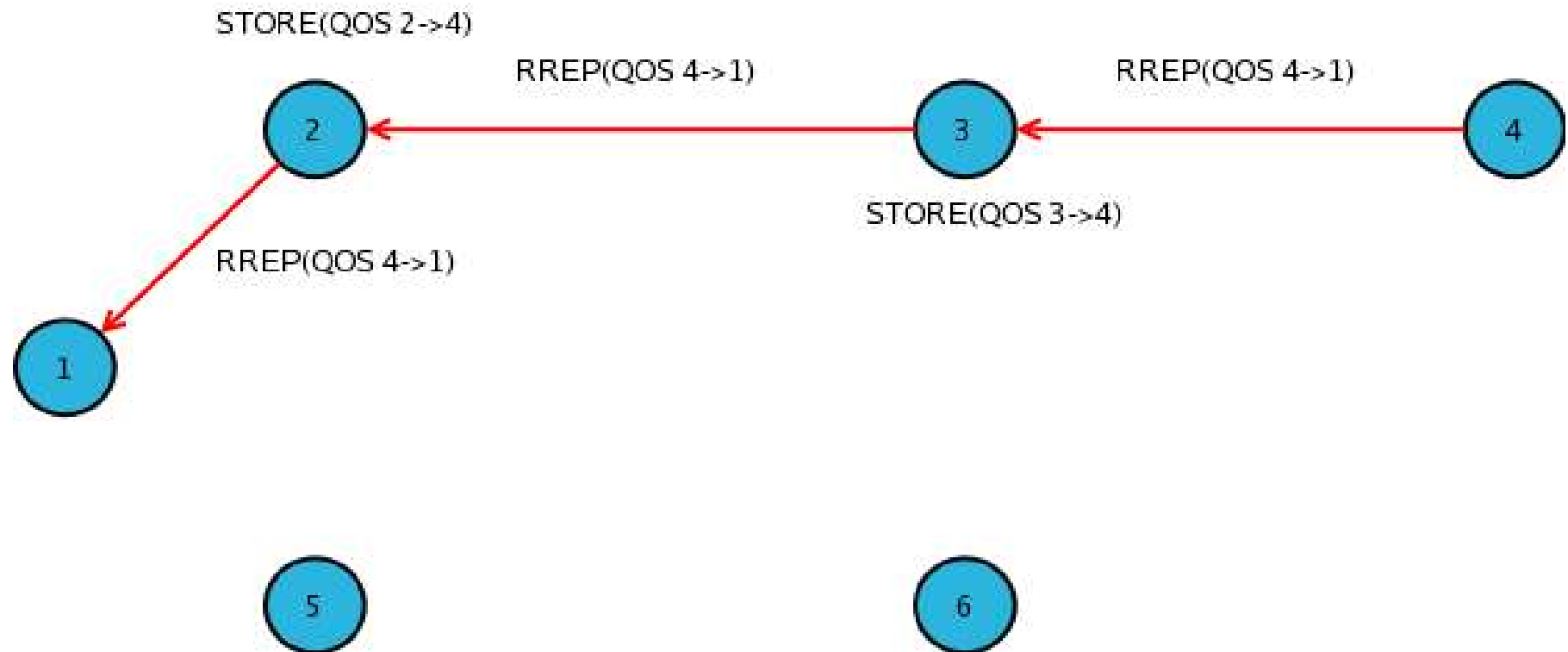


Cross Layer and Ad-hoc Networks(3/4)



SOURCE node 1
DESTINATION node 4

Cross Layer and Ad-hoc Networks(4/4)

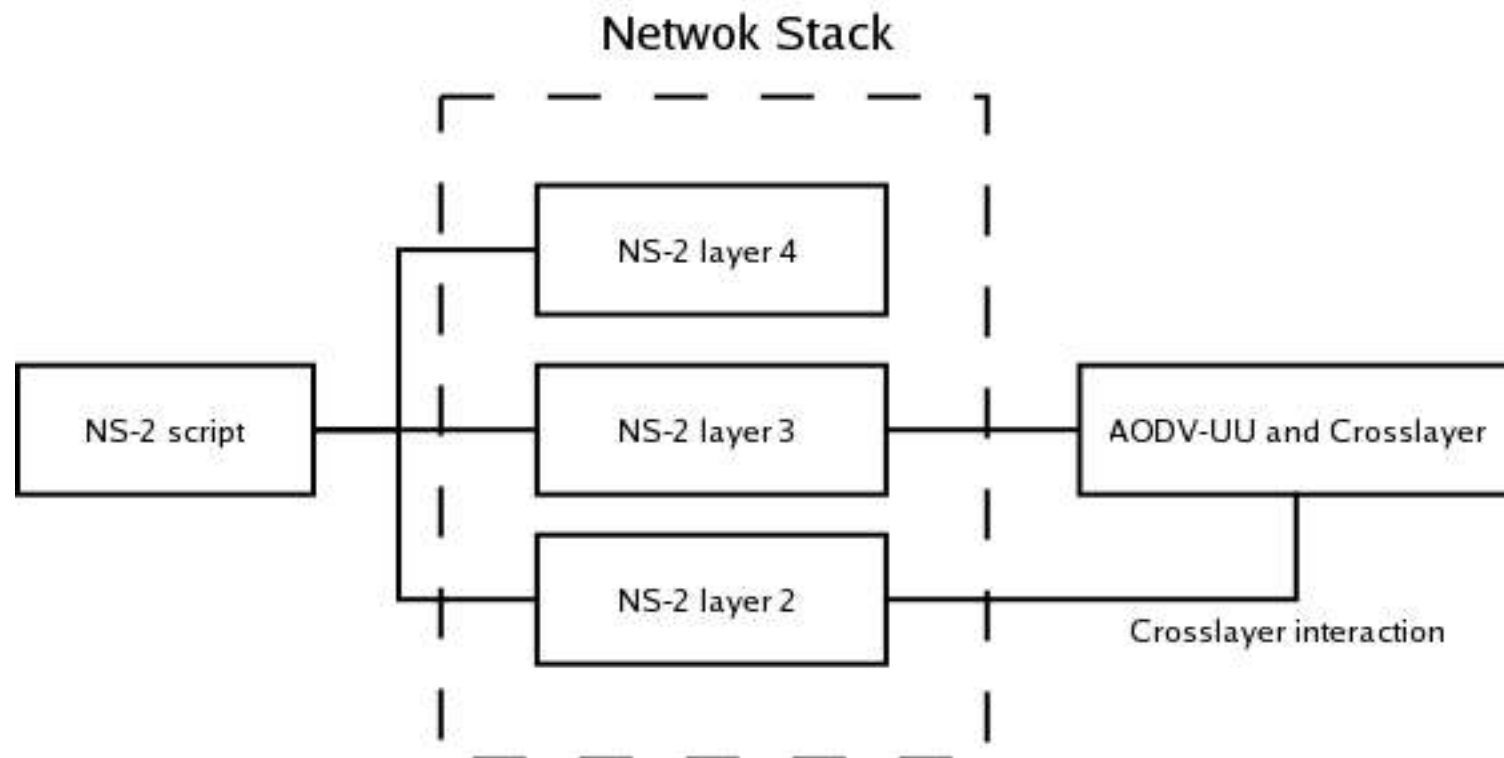


SOURCE node 1
DESTINATION node 4

Cross Layer and Ad-hoc Networks(1/4)

- Check the interlayer interaction with AODV
- RREP and RREQ to carry interlayer info
 - Use aodv extension field to carry informations
- Create interfaces MAC/routing layer
- Change the network metrics

Cross Layer and Ad-hoc Networks(2/4)



Expected results

- Multiuser diversity improves the network capacity
- Select an high quality route
- Select the best route
- Monitoring of the quality of the route over the time

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On progress Works

- Simulate the effects of :
 - Multiuser Diversity
 - Best available path rate
- Difficulty to perform significant simulation with multi-layer interaction
 - Aggregation Techniques
- Create a new stack design

References

Vikas Kawadia and P. R. Kumar. **A Cautionary Perspective on Cross Layer Design.** *Submitted to IEEE Wireless Communication Magazine 2003*

Douglas S. J. De Couto and Daniel Aguayo and Benjamin A. Chambers and Robert Morris. **Performance of Multihop Wireless Networks: Shortest Path is Not Enough.** *Proceedings of the First Workshop on Hot Topics in Networks (HotNets-I), ACM SIGCOMM, 2002*

Andrea J. Goldsmith and Stephen B. Wicker, **Design Challenges for Energy-Constrained Ad Hoc Wireless Networks,** *IEEE Wireless Communication, 2002*

Baruch Awerbuch and David Holmer and Herbert Rubens, **High Throughput Route Selection in Multi-Rate Ad Hoc Wireless Networks,** *First Working Conference on Wireless On-demand Network Systems (WONS 2004)*

Thanks

Questions ?